Jumping to Quadratic Models

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A Second Classroom Scenario

Example 2

Four students (Donovan, Erika, Finley, and Gabrielle) are working together. Their plan involves having Donovan jump while Erika and Finley both try to estimate his jump height against a yardstick and Gabrielle times his jumps with a stopwatch. The group records the average of Erika's and Finley's estimates. (See **table 4**.) After collecting data from several jumps, the group plots the data. (See **fig. 4**.)

"It's linear!" Gabrielle exclaims, happy to have such a clear result. Other members of her group agree that the data appears linear, and they calculate the slope, using the first and last points:

$$m = \frac{15.2 - 12.6}{0.56 - 0.51} \approx 52.24$$

The group uses this information along with the data from Donovan's first jump to find the equation of the line to be $y = 52.24x - 14.12$. "Wait. If that's our model, what does that negative y-intercept mean?" asks Finley. Erika points out that it means if Donovan's jump duration is 0 seconds, he jumped –14.12 inches, which does not make sense. The group sends Donovan, their ambassador, to the other groups to try to get unstuck. He returns after talking to another group that is gathering jump data from multiple people. This group's data was more spread out than his was, but it gave him an idea. Donovan explains to other members of his group that he was going to do some small jumps intentionally to see where the line went wrong. They also record a height of 0 inches when the jump duration is 0 seconds. (See **table 5** and **fig. 5**.)

"Is that exponential?" Erika asks. Finley agrees that it really looks exponential. Donovan isn't so convinced. "But can an exponential actually be zero?" "It looks kinda like a parabola," noted Finley. The others agreed. They also noted that it was the best guess they had at the time and so set to work trying to make a quadratic model.

First they notice that the vertex is at the origin, so they write an equation in vertex form: $h(t) = a(t - 0)^2 - 0 = at^2$. Then, using a graphing calculator, they manipulate possible values for a, resulting in $h(t) = 48.4t^2$. The group members use their model to see how accurate it is given their measurements and are satisfied with the results. The group compares their model to their peers' and the class as a whole discusses any discrepancies.

Table 4 Donovan's Jump Data

t (seconds)	h (inches)
0.54	14.1
0.52	13.2
0.51	12.6
0.53	13.2
0.53	13.1
0.53	13.8
0.55	14.5
0.53	13.5
0.56	15.2

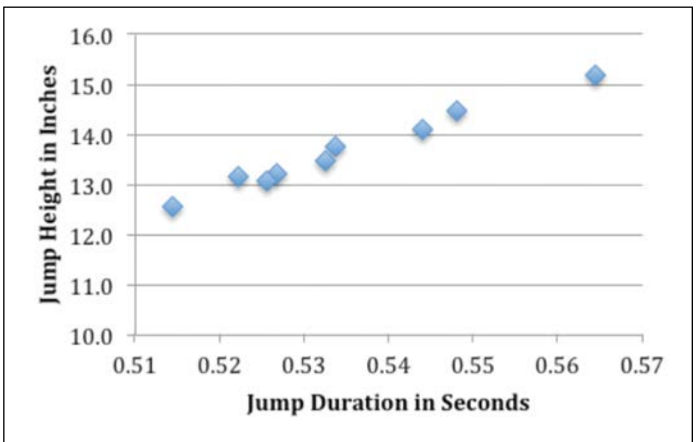

Fig. 4 Donovan's jump data appears roughly linear.

Table 5 Donovan's Additional Jump Data

t (seconds)	h (inches)
0.37	6.5
0.34	5.6
0.27	3.6
0.26	3.4
0.00	0

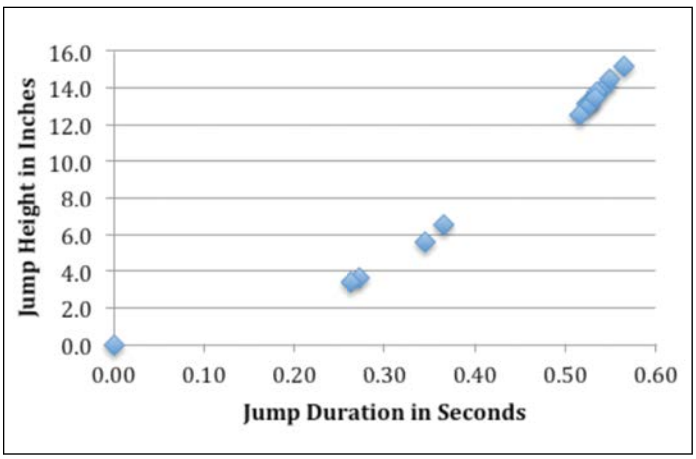

Fig. 5 The group's intuition that the data is likely not linear is confirmed.